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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/643,980	08/20/2003	Shuji Hirao	60188-635	4984

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McDERMOTT, WILL & EMERY
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Washington, DC 20005-3096

EXAMINER

EVERHART, CARIDAD

ART UNIT	PAPER NUMBER
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2825

DATE MAILED: 07/12/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/643,980

Applicant(s)

HIRAO ET AL.

Examiner

Caridad M. Everhart

Art Unit

2825

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s).

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>8-2-2003</u> . | 6) <input type="checkbox"/> Other: ____. |

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-3,5-7,9,10, 12, are rejected under 35 U.S.C. 102(b) as being anticipated by Ding, et al. (WO 99/33110).

Ding et al disclose the steps of growing a first conductive layer of copper as a seed layer(page 12 lines 20-24). The copper has a crystal structure(page 12, lines 20-24), and is deposited by sputtering (page 11, lines 19-24 and page 12, lines 1-3 and page 10, lines 1-4). A thicker layer of copper is deposited on the seed layer of copper and annealed(page 12, lines 20-24 and page 13, lines 10-20). It is implied in the disclosure of the copper layer that the seed layer and the subsequently deposited copper form one layer, as it is disclosed that the combination is annealed and that the crystal structure of the seed layer determines the crystal structure of the subsequently deposited copper(page 13, lines 17-20). The resistivity of the copper is smaller than the value recited in claim 3(page 1, lines 13-14). The film is grown at a temperature within the recited range, and the anneal temperature is within the recited range(page 12 lines 1-3 and 20-22)because the melting point of copper is 1083 degrees C. The barrier is Ta(page 12, lines 4-5). The second conductive film may be deposited by plating or by CVD(page 13, lines 16-20). The films may be formed in a contact opening, which would

be a concave opening in an insulation layer (page 12, lines 24-24 and page 13, line 1).

The structure may be planarized by CMP(page 12, lines 4-13).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ding, et al as applied to claims 1 and 7 above, and further in view of Kishida et al (US 2002/0190352A1).

Ding et al is silent with respect to the tantalum being of beta structure.

Kishida is relied upon for its teaching that tantalum with beta structure is compatible with the copper seed layer in the formation of contact openings(paragraph 0012 and 0013 and Fig. 7B shows a damascene structure).

It would have been obvious to one of ordinary skill in the art at the time of the invention to have combined the disclosure made by Kishida with the process taught by Ding et al in order to obtain the benefit of improved adhesion taught b Kishida.

Claims 4, 13,¹⁴_A15, 16, 17, 18, 19, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ding et al as applied to claim 1 above and further in view of Rathore, et al (US 6,069,068).

Ding et al is silent with respect to the relative thickness of the seed layer of copper and the fill layer of copper, although Ding et al does indicate that a 1000 Angstrom thick layer of copper is sputtered(page 12, lines 1-3), and it is disclosed that the seed layer is a sputtered layer, as pointed out in the above rejection. As pointed out above, Ding et al does teach the planarization step recited in claim 16. Ding et al is also silent with respect to the resistivity before the anneal.

Rathore et al is relied upon for its disclosure that the copper seed layer can be up to 20% of the thickness of the via fill (col. 2, lines 8-16) and 1100-2000 Angstrom in the prior art(col. 10, lines 65-67 and col. 11, lines 1-5).

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It would have been obvious to one of ordinary skill in the art at the time of the invention to have formed the copper seed layer in the process taught by Ding et al in the recited range because Rathore et al disclose that it was known in the prior art to form the copper seed layer less than 20% of the total thickness, and because Ding et al teach a thickness less than the 1100-2000 Angstroms which in the prior art would have corresponded to less than 20% of the total thickness.

With respect to the resistivity before the anneal, although Ding et al is silent with respect to this limitation, it would have been obvious to one of ordinary skill in the art at the time of the invention that the resistivity would have been reduced by the anneal, and because the resistivity is a variable of the art, obtaining the recited values would have been within the ordinary skill in the art.

Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ding et al as applied to claim 1 above, and further in view of Ding et al (US 6,352,926B1).

Ding et al as applied to claim 1 above is silent with respect to the low anneal temperature.

Ding et al (US 6,352,926B1) discloses a low anneal temperature of 150 degrees C (col. 10, lines 25-30). Because it is disclosed that the reflow began at 150 degrees C and that the reflow can be carried out at a temperature or over a temperature ramp, this is interpreted as that the temperature can be 150 degrees C and need not necessarily be ramped.

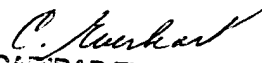
It would have been obvious to one of ordinary skill in the art at the time of the invention to have used the temperature disclosed by Ding et al (US 6,352,926B1) in the process taught by Ding et al because the lower temperatures prevent unwanted reactions.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Caridad M. Everhart whose telephone number is 571-272-1892. The examiner can normally be reached on Monday through Fridays 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew S. Smith can be reached on 571-272-1907. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

C. Everhart
7-6-2004


CARIDAD EVERHART
PRIMARY EXAMINER